

CRUSHED STONE JOURNAL



JUNE 1960

OFFICIAL PUBLICATION OF THE NATIONAL CRUSHED STONE ASSOCIATION



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Cover Photograph—Security Quarry of the North American Cement Corporation, Hagerstown, Maryland. Approximately one square mile in area, 3 level, open face limestone operation; height of faces from top level down, 30, 102, and 50 ft.

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Stone Sand For Masonry Mortar

By J. E. Gray, Engineering Director

J. E. Bell, Assistant to Engineering Director

National Crushed Stone Association
Washington, D. C.

THERE is an American Society for Testing Materials tentative specification for aggregate for masonry mortar, C 144-52T, which gives the requirements for manufactured stone sand as well as natural sand. However, the statement has been made that some reputedly good natural sands will not meet these requirements. Also, the requirements for stone sand are based primarily on experience with very little test data.

In order to possibly revise these specifications, Subcommittee IV of ASTM Committee C-12 planned a program of cooperative tests in which the National Crushed Stone Association was one of the participants. The subcommittee submitted the masonry cement and a natural sand and suggested that each cooperating laboratory select another sand to be included in the investigation. A commercially prepared masonry stone sand was chosen for the second sand. The data herein reported are the results of tests of this program as conducted in the NCSA Laboratory. The data should be particularly helpful in indicating a good gradation for stone sand for masonry mortar.

Five different aggregate gradings were investigated with 2 mortars, 1 of which had a low entrained air content of about 10 per cent and the other a high entrained air content of slightly over 30 per cent. The mortar proportions were 1 part masonry cement to 3 parts sand by damp, loose volume. A Type II air entraining masonry cement was used for the low air content mortars. For the high air content mortars the same masonry cement was used and Vinsol resin was added to increase the air content. With the proportions of cement to sand being constant and the flow being within 105 and 115 per cent or essentially constant, the variable was the water content. Tests were made for water retention value or flow after suction, unit weight, air content, compressive strength, and shrinkage caused by drying.

¹"Stone Sand for Use as Fine Aggregate," by A. T. Goldbeck, *Crushed Stone Journal*, June 1951

Properties of Aggregates

The 5 aggregate gradings and the corresponding values for specific gravity, absorption, unit weight, and per cent voids for the 2 different sands used in the mortar mixes are shown in Table I.

An indication of the particle shape of the 2 sands was obtained by the National Crushed Stone Association's Particle Shape Test.¹ By this test the average per cent of voids for individual sizes of the natural sand was 47.6 per cent while that of the stone sand was 51.2 per cent, which indicated that the stone sand was sufficiently well shaped in the normal production processes to provide good workability.

Desirable Properties of Mortar

Although there is little agreement as to the relative importance of the various properties of masonry mortar, it is generally conceded that the mortar must be workable; it must hold or retain a large part of its water to remain plastic when placed on highly absorptive masonry units, yet it must not tend to float highly impervious units, nor should it bleed and stain the face of the units. The mortar joint should be somewhat permeable to water vapor in order that moisture may escape from cavity walls above grade where impervious masonry units are used, but at the same time it should have good freeze-thaw and weathering resistance.

For construction above and below grade the mortar should be impervious to the passage of water; consequently, volume change of the mortar upon drying should be small in order to minimize cracking of the mortar joints which would allow the free passage of water into the structure. The mortar should bond well to the masonry units and have sufficient strength so that the transverse strength of the masonry construction is not impaired.

While this is not a complete listing of the properties that are important in mortars, it does

indicate that in the choice of a mortar or of an aggregate for mortar no single factor or property should dominate to the exclusion of all other factors.

Workability

In considering workability, it should be remembered that mortar is placed by hand; therefore, the human factor, the mason, must be taken into account. In fact, there are no structural materials controlled more by the opinion of the mechanic using them than are masonry sands. The mortar must be plastic and must possess the ability to stick together, yet not be sticky enough to adhere too strongly to the trowel. Workability may be judged to some extent by the flow test, but the final judge is always the mason.

Since the flow was held constant for the mortars of this series of tests, an attempt was made by those conducting the tests to rate the individual mixes as to workability by the ease with

which they could be troweled and by feel of each mix under the trowel. It was agreed by the 3 men conducting the tests that mortar containing either stone sand or natural sand of Grading No. 1 was harsh and not very workable even in the high air content mixes. The mortars prepared from the other 4 gradings for both stone sand and natural sand with low and high air contents were all judged to be equally workable.

As the ratio of Type II masonry cement to aggregate by solid volume was held substantially constant for all of the mixes tested and the flow for each mix was maintained between 105 and 115 per cent, the water-cement ratios given in Table II and shown graphically in Figure 1, illustrate the increased water requirement, as the sands become finer, to obtain the same flow. The one notable exception to this general relationship is the low air content mix containing stone sand of Grading No. 2.

TABLE I
RESULTS OF TESTS ON SANDS

	Grading No. 1		Grading No. 2		Grading No. 3		Grading No. 4		Grading No. 5	
Gradation										
Total per cent passing										
No. 8	100		100		100		100		100	
No. 16	60		88		85		87		95	
No. 30	35		60		50		67		75	
No. 50	15		8		25		22		35	
No. 100	2		2		8		2		15	
Fineness Modulus	2.88		2.42		2.32		2.22		1.80	
Type	Natural Sand	Stone Sand	Natural Sand	Stone Sand	Natural Sand	Stone Sand	Natural Sand	Stone Sand	Natural Sand	Stone Sand
Specific Gravity at 68 F										
Bulk dry	2.62	2.78	2.62	2.77	2.63	2.78	2.62	2.79	2.62	2.78
Apparent	2.66	2.83	2.66	2.83	2.67	2.83	2.67	2.83	2.67	2.83
Absorption, per cent	0.63	0.59	0.66	0.75	0.57	0.62	0.64	0.51	0.77	0.63
Unit Weight Solid, lb per cu ft	163.3	173.2	163.3	172.6	163.9	173.2	163.3	173.9	163.3	173.2
Dry rodded, lb per cu ft	107.1	110.7	101.9	104.3	107.4	113.2	102.3	106.6	106.2	113.0
Voids, per cent	34.4	36.1	37.6	39.6	34.5	34.6	37.4	38.7	35.0	34.8

TABLE II
SUMMARY OF RESULTS

	Grading No. 1		Grading No. 2		Grading No. 3		Grading No. 4		Grading No. 5	
Air Content	Low	High	Low	High	Low	High	Low	High	Low	High
Water Cement Ratio by Wt										
Natural Sand	0.54	0.54	0.61	0.55	0.61	0.60	0.63	0.60	0.67	0.67
Stone Sand	0.58	0.54	0.68	0.60	0.62	0.60	0.66	0.61	0.68	0.64
Water Retention Value										
Natural Sand	69.7	92.5	62.8	86.4	68.5	88.9	60.7	88.9	65.3	87.5
Stone Sand	55.3	83.8	50.3	81.9	57.3	86.0	54.8	83.9	57.4	78.3
Air Content, per cent										
Natural Sand	9.3	32.5	11.8	32.2	10.2	34.1	11.3	33.8	9.9	32.3
Stone Sand	9.0	30.5	11.4	35.2	9.7	30.8	11.7	34.1	9.9	28.9
Compressive Strength, psi										
Natural Sand	2100	520	1530	560	1680	430	1450	490	1390	480
Stone Sand	1960	660	1280	510	1700	610	1370	550	1470	730
Drying Shrinkage, per cent										
Natural Sand, after										
3 days drying	-.034	-.038	-.034	-.056	-.040	-.059	-.038	-.061	-.040	-.058
6 months drying	-.063	-.068	-.076	-.081	-.070	-.082	-.070	-.082	-.070	-.078
Stone Sand, after										
3 days drying	-.024	-.050	-.029	-.044	-.024	-.030	-.028	-.038	-.037	-.032
6 months drying	-.060	-.074	-.064	-.066	-.064	-.062	-.064	-.066	-.066	-.067

Water Retention

Although it is important that a mortar be workable initially and behave properly when handled with a trowel, it is perhaps equally important that the mortar remain plastic or work-

able for a considerable length of time after it has been used in laying block or brick. The mason does not level and align the units precisely as he lays them, but often lays 1 or more courses before he tamps them into their final place. If the mortar is not sufficiently plastic, this final tamping may break the bond between the units and the mortar and possibly impair the strength of the structure; this can also create small cracks that can allow the passage of water. Mortar, then, should retain its plasticity even when used with highly absorptive masonry units; this means that the mortar must retain a large portion of its water.

The measurement of how well a mortar holds its water is the "water retention value" which is the ratio of the flow of mortar after being subjected to suction under prescribed conditions to that of fresh mortar. Thus, a water retention value of 100 would mean that mortar had the same flow after suction as fresh mortar and presumably had lost none of its water.

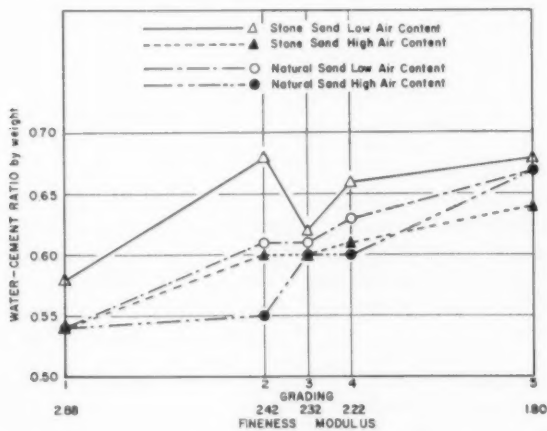


FIGURE 1
Effect of Grading on Water-Cement Ratio

Figure 2 shows the water retention value for each grading of each sand at both low and high air contents. The effect of air content on the water retention is quite evident from this graph;

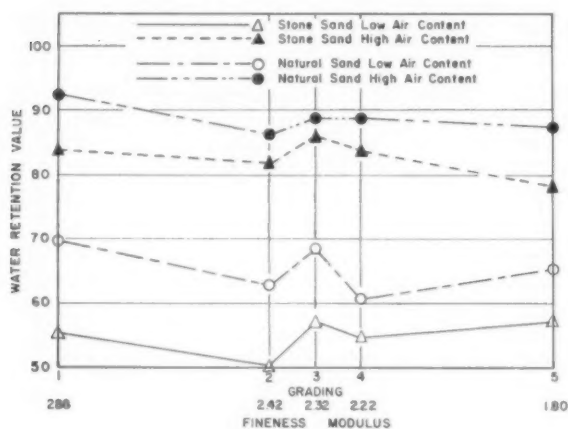


FIGURE 2
Effect of Grading on Water Retention Value

both the stone sand and natural sand mortars with high air contents would be considered to have sufficient flow after suction. Disregarding the mortars containing aggregates of Grading No. 1 because of poor workability, Grading Nos. 3 and 4 for both sands appear to be the most desirable with respect to water retention for high air content mortars. It may be noted that the high air content stone sand mortars of Grading Nos. 2, 3, and 4 had water retention values closely approaching those of the natural sand mortars of the same grading. On the other hand, the low air content mortars containing stone sand did not retain their water as well as those containing natural sand.

Compressive Strength

Many years ago the strength of mortar was of special consideration. Some of the mortars that were used had little strength at early age and the weight of walls of any considerable height could conceivably overstress the weak mortar. With the wide variety of cementitious materials available at the present time, however, there is little cause for concern over being able to secure adequate strength except in special cases such as load bearing pillars or reinforced masonry construction. Bond strength is important but high compressive strength does not insure high bond

strength. Of course, there may be an economic saving possible by use of an aggregate grading that gives high strength mortars.

Figure 3 shows the compressive strengths obtained for mortars prepared in this series of tests. For the high air content mortars, the 2 types of sand give comparable strengths. Likewise, the strengths are somewhat comparable for the low air content mortars. Disregarding Grading No. 1, Grading No. 3 is probably the best, especially for stone sand.

Drying Shrinkage

The importance of volume change caused by drying in masonry mortar as well as in concrete has been a subject of much discussion for years; but no amount of discussion has been able to change the fact that as mortar shrinkage occurs, stress increases until it is sufficiently large to cause a physical separation of the mortar, a crack. The stronger the mortar, the farther apart the separations will be; theoretically, they will also

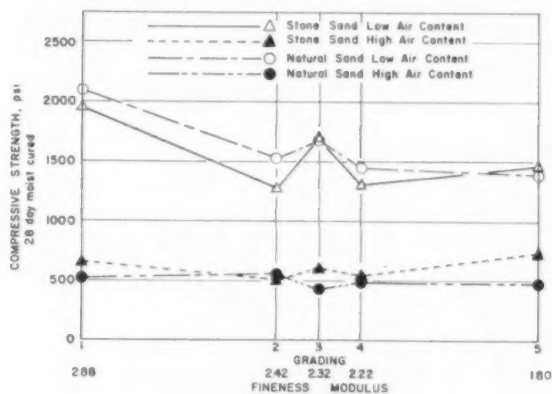


FIGURE 3
Effect of Grading on Compressive Strength

be larger. Instances of water entering such cracks with resulting damage to the structure are numerous. It is, therefore, extremely desirable that major consideration be given to those factors which minimize the formation of shrinkage cracks.

Figures 4 and 5 show the results of drying shrinkage measurements for the mortars made in this series of tests. If only the mortars of good workability are considered, it may be seen

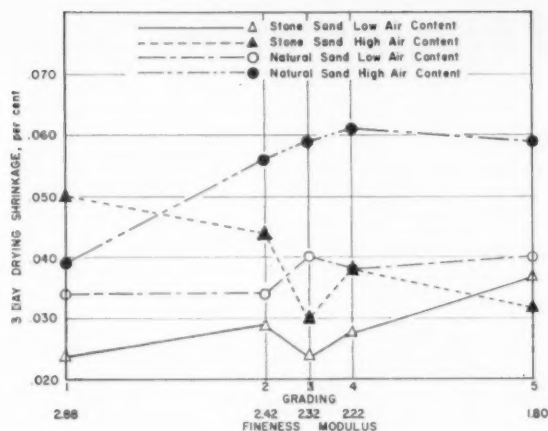


FIGURE 4

Shrinkage Caused by 3 Days Drying at Room Temperature. Specimens Initially Moist Cured for 28 Days

that, throughout 6 months exposure to approximately 55 per cent relative humidity and room temperatures the mortars containing stone sand have consistently shown less shrinkage than those containing natural sand. Mortar containing stone sand of Grading No. 3 had a shrinkage of 0.062 and 0.064 per cent for the high and low air contents, respectively, after 6 months drying. Lowest shrinkage for the natural sand mortars occurred with grading No. 5 which, for the low air content mix, had a shrinkage of 0.070 per cent, and for the high air content mortar exhibited a volume change of 0.078 per cent. In other words, it would seem reasonable to expect stone sand mortars to have less drying shrinkage cracks than natural sand mortars.

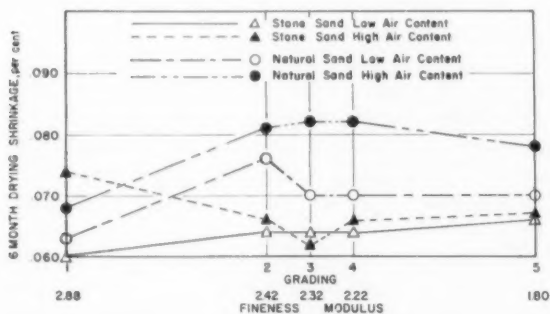


FIGURE 5

Shrinkage After 6 Months Air Drying

Summary

The curves, in general, fail to show a trend from the coarsest to the finest grading. It is interesting to note that the percentage of voids in the aggregates are low and approximately the same for Grading Nos. 1, 3, and 5; and rather high for Grading Nos. 2 and 4. Possibly, this may have some significance with respect to the peaks and valleys at Grading No. 3 as compared with Grading Nos. 2 and 4.

From these tests there are no truly significant differences in the properties of mortar made with stone sand and those made with natural sand when all things are considered. While it is quite true that the natural sand mortars had slightly better water retention values, it is equally true that the stone sand mortars exhibited smaller volume changes upon drying. As to the gradation, it has been said that in order to gain one desirable property another is sacrificed—the most satisfactory gradation is the one that offers the best balance of the 4 factors under study which influence the use or performance of mortars.

Grading No. 1 produced mixes that were judged to be too harsh. Grading No. 2 with its high percentage retained between the No. 30 and No. 50 sieves and with little passing the No. 50 sieve produced mortars having low water retention, low compressive strength in 3 out of 4 of the different mixes, and intermediate drying shrinkage. Mortars made with aggregate of Grading No. 3 had good water retention values, relatively high compressive strength in 3 of the 4 mixes, low volume change for the stone sand mixes, but high volume change for the natural sand mixes. Grading No. 4 with its low percentage passing the No. 100 sieve produced mortars having rather low water retention, intermediate compressive strengths, and intermediate drying shrinkage. Mortar prepared with aggregate Grading No. 5 had, in general, fair water retention values, intermediate compressive strength, and relatively low drying shrinkage for the natural sand mixes; but stone sand mortars with this grading had relatively high drying shrinkage when compared with the other stone sand mortars. Thus, it appears that Grading No. 3 is the most desirable of the 5 gradings tested for manufactured stone sand for masonry mortar. /NCSA

Transportation Policy and Program of the United States¹

By Hon. John J. Allen, Jr.

Secretary of Commerce for Transportation
U. S. Department of Commerce
Washington, D. C.

IT IS a pleasure to respond to your Chairman's words of greeting as I return to Oakland, and I join in a cordial welcome to those of you who have come across the Bay for this occasion. This is truly an East-West summit meeting of this area's transportation.

I am very pleased to be making this talk in Oakland. It is my first public discussion of the recent report of the Secretary of Commerce to the President on transportation policy and program, a report which has been a major activity of my office for the past year or more. It is appropriate that such a presentation should be made here. Oakland and the East Bay has long been a transportation center. It was here that the first transcontinental railroad terminated. It was here that one of the first major airports in the nation was established. It is here that major highways converge, and the highway users center their terminal operations. It is a major seaport, and the pipelines of several major oil refineries terminate on the East Bay shores.

It is here that the Army and the Navy have established major ports of embarkation through which flowed most of the supplies which fed the forces in the Pacific and in Korea during the last two major conflicts.

It is here where rail and truck meet water and overseas air that the coordination between modes of transportation can, and has already made great progress. In this area, which owes its progress and prosperity to the transportation center established here by nature, a discussion of this subject should always be timely.

How Policy Is Determined

What does a report and study of this character accomplish that could not be done by other means? Could not the policy decisions of our government

be settled out of the knowledge and experience of our political and business leaders and done more quickly than through the means we have chosen? It would be nice if transportation policy decisions could be reached by these simple means, but they cannot. If the solutions were simple and free from controversy, not to mention conflicting interests involving billions of dollars and thousands of people, we would not have needed a transportation report.

Our transportation report is typical of the kind of attention that must be given to major problems facing the public, and which involve both government and private enterprise.

In our society we do not have centralized management of transportation policy. It is inevitable that the various forces, private and public, in so complex a field would have hauled in different directions, and some very badly coordinated results have become evident. There has been lacking for many years adequate authority and adequate staff to coordinate federal policies. This report is a preliminary effort to provide a better understanding of what is involved in national transportation policy and its administration.

We cannot stop at this report. We must go on to provide the resources to carry out the recommendations.

The problems are complex and must receive the benefit of expert analysis. In the second place the public interest involved is substantial and the research and conclusions must be understood by those with authority, with power to act responsibly in accordance with our conception of popular government.

Without the sponsorship and advocacy of those in power, we would have just another report "gathering dust on the shelves." Unless we have the expert analysis we will find that those in authority will not be fully informed and the

¹ Presented at a special Transportation Luncheon sponsored by the combined Chambers of Commerce and Transportation Associations of the Oakland-San Francisco Metropolitan Region, Athens Athletic Club, Oakland, California, April 14, 1960

quality of their decisions will suffer. The history of transportation shows examples of both kinds of failings.

The work of the Department of Commerce in transportation under this Administration shows the best combination of expert study and authoritative sponsorship. In addition to the present report we have had the previous report of the Presidential Advisory Committee under the Chairmanship of Secretary Weeks. Both reports dealt comprehensively with transportation as a public policy issue.

Unless we evolve an orderly process of policy planning reports, the making of decisions in government becomes a haphazard process. Vital interests become neglected, favoritism is easily possible, and sometimes outright injustice is a result. Often policy has been made in the old doctrine that the "wheel that squeaks loudest gets the grease." As a result we have neglected vital things because the pressure was in some other direction. In certain other cases vital parts of our economy have become politically expendable. In the economic sphere this is a dangerous pitfall, because the very fact of efficiency can cut an industry off from some of the vested interests which generate political support. Conversely, the advancement of many vital economic activities can generate a storm of opposition which the government executive may not wish to face.

The unfortunate processes of decision making just discussed inevitably lead to a third unfortunate kind of decision making, the crash project or crash decision which neglect all too often forces upon a government. We cannot formulate the nation's transportation policy by a process of crash decisions.

Program Based on Technical Studies

In the field of transportation we are making a tremendous step forward with our transportation study report. In one document policies affecting investment of public funds in transportation have been assessed at the same time and in the same terms as regulatory policy. Our report has also measured the impact upon transportation of general governmental policies; such as labor, taxation, national defense, and government procurement. In all, the report makes 78 fundamental recommendations for policy changes in transportation covering the entire comprehensive field.

The process we used to make the study illustrates the type of rational development we need as a regular part of our government structure if we are to govern wisely in matters affecting complex economic areas. If we had made provision for coordinated administration in the past, we would not have needed so comprehensive a report at this time.

The foundation of the report is a series of technical studies prepared by outstanding specialists in each of the subfields of transportation who were retained from universities and consulting firms. Some 15 of these technical reports were prepared. During their course of preparation the consultants received the aid and advice of the staff specialists employed regularly by the Department, many of them long time government employees with extensive experience in dealing with public policy issues.

When the consultant reports were finished they were reviewed by panels of practical men from transportation industry who participate in the Department's Transportation Council. The Council prepared a series of commentaries on the various reports. In addition, a special panel of the Department's Business Advisory Council was kept informed of the report's progress at all times. The members of this panel gave us the benefit of their counsel against their background in the American business community.

These steps were all repeated in the preparation of the final reports; preparation by a consulting staff, review by permanent staff, review by the Transportation Council for the point of view of transportation industry, and review by the Business Advisory Council for the point of view of the general business community. Departmental officials participated in this review process. Both the Secretary and I attended some of the panel meetings with the Transportation Council and the Business Advisory Council. I also discussed the draft of the final report with my permanent staff in a special meeting held for that purpose.

I describe this process to indicate the combination of technical capacity, practical knowledge, and executive responsibility that went into the making of the transportation report. There is a school of thought, I know, which believes decisions of public policy are made by getting the rival interests together and reaching a consensus of their positions. We have rejected that approach. While all have been consulted, this is a report of the Secretary of Commerce. His recommendations

are intended to be decisive. They are meant to solve long-standing problems, not to reconcile conflicting interests. Our research and consultative process did not admit of doctrinaire positions. We dealt with individuals and experts, not interest representatives. We based our thinking on the public interest rather than the interest of the transportation industry or any part of it.

Factors in Determining Current Recommendations

Our researches and consultations disclosed many serious and complex problems affecting all areas of transportation and raised a great issue of policy. Is the fundamental problem of transportation political or economic? Should the problems be solved by political means, which imply more direct governmental action and regulation, or should the normal workings of the economic system be utilized in resolving the problems? Due to the extent of existing governmental activity, any further advance in the political direction would involve a major exercise in paternalism.

Our choice in favor of greater economic freedom was based, not so much on our dislike of governmental activity, as it was on our finding that the basis of transportation issues has become economic. In the past, regulation was imposed to secure a political objective; the protection of certain groups against exploitation. It was continued to protect the carrier groups, first against ownership by the government itself, and second to help other groups become established in the transportation field, even to the extent of subsidization. We have now passed through that stage. We are faced with the needs for transportation by a growing economy. We want to perform our transportation job with the utmost conservation of resources. To do these things transportation can rely on the same methods and principles with which other industries have taken advantage of economic opportunity.

General Categories of Recommendations

All of our 78 recommendations were made in the light of this most significant finding. They may be divided conveniently into four categories:

1. Economic regulation
2. Public investment
3. American flag operations in international transportation

4. General governmental policies, such as labor, defense, taxation, and government procurement, which affect transportation

Economic Regulation

In tackling the issue of economic regulation of transportation we are in a sensitive subject. Economic regulation applies today in a very comprehensive manner to the rates and the business structures of all forms of transportation. Regulation came about in the first instance to deal with specific social issues. The political sentiment surrounding this fact still exists, and the old, outdated political issues are still raised whenever anyone tries to modify regulation to conform to more modern economic needs.

Moreover, the past pattern of regulation has created many vested interests in a status quo. All forms of transportation, however, have now reached a mature stage and it is time to allow future patterns of growth to be determined by the free choices of the sovereign customer rather than the sovereign government.

In the movement of freight, the ultimate decision on what price to pay and what carrier to use is vested in the shipper or his traffic manager. In the case of passengers, the traveler or his agent makes the decision. The combination of all these decisions makes the market for transportation services. This is similar mechanism to that which works in other forms of industry. The market sets the price and encourages businesses to make investments or extensions of service.

In transportation regulation often comes between the carriers and the market. Originally regulation was imposed to protect the shipper against monopoly, but transportation today is competitive with no one mode dominating the business. In fact, competition is increased by the fact that the shipper himself can provide much of his own transportation if he is not satisfied with carrier services.

Under modern regulation, the standards of competition have become the main focus. If a carrier loses business to another, he is not encouraged to meet the rate or to improve his service. Instead he can protest the rate to the regulatory commission who may hold up his competitor's rate and return some of the business to him.

In a similar way, if a new man wants to enter a transportation business, or if an established carrier wants to expand, permission must be sought for every detail of the transaction from

the regulatory commissions. In almost every case, competitive carriers intervene and seek to use the powers of government to protect their vested markets.

Regulation is particularly restrictive when one carrier seeks to expand into another form of transportation. The present laws also fall unequally upon the various forms of transport in this respect.

With every individual rate potentially the subject of regulatory action, along with every move made by thousands of carriers in expanding or contracting their businesses, it is not surprising that the regulatory bodies have become bogged down in detailed casework. This attention to minute detail has prevented the regulatory bodies from concentrating on major policy decisions affecting the progress of transportation.

The main problem of transportation is no longer the protection of the public from monopoly, for we have competition. It is no longer the protection of developing carriers, for they have all reached a high state of development. Today our problem is a national one of economic expansion and financial stability. Transportation must grow and make its contribution to the expanding economy. Transportation must contribute to our other national objectives such as financial stability and the conservation of resources. It is the modern job of regulation to guide the industry toward these goals. Constructive work is needed in technical developments and their applications, in the study of carrier costs and their application to pricing, in the growing need for carrier services of different kinds and the type of carrier organizations that can best supply them. The regulatory commissions must be relieved of their detailed chores, and given the resources to guide transportation along fundamental policy lines.

I do not in any way criticize the operations of the regulatory commissions. They are apparently doing the job the law requires of them. But the law should permit them a more constructive role in guiding the carriers to meet the economic challenge ahead. This cannot be done under the heavy case workload which now burdens every one of them.

In our transportation report we recommended a steady, time-phased elimination of detailed control by regulatory bodies over rates and over the conduct of carrier businesses. We would retain sufficient protection to the public against unreasonable acts and discrimination, and allow the

regulatory authorities broad latitude to guide and assist in the development of the transportation industries. We would decrease their detailed caseload, and increase their resources for research to these ends.

Public Investment

In addition to regulation, public investment in transportation facilities is a second great area of transportation policy. We have used the term public investment as a shorthand expression to cover the use of public funds in the provision of highways, inland waterways, ports and harbors, airports, airway facilities, and other public properties used in transportation.

It is a distinctive feature of modern developments in transportation that the newer forms require public facilities upon which to operate. The operation of motor carriers, water carriers, and air lines depends on public tax moneys invested in such things as highways, river and harbor improvements, and airports and air navigation aids. So ordinary an event as a trip in your private automobile could not take place without a public investment program.

In the public investment side of transportation we find a division of function among governmental units. Waterways, harbor improvements, and the provision of air navigation aids is a direct responsibility of the federal government through such agencies as the Corps of Engineers and the Federal Aviation Agency. In the highway field, on the other hand, we find state government providing the main facilities, with many thousands of miles of local roads and streets administered by local and municipal governments, usually with substantial state aid. Federal participation in the highway program is through grants-in-aid to state highways, rather than through direct construction activity. In the case of airports and port terminals facilities we find a partnership of municipal government and private enterprise. Federal funds are granted regularly to aid municipalities in the construction of airports.

The federal role in the provision of investment funds for basic transportation facilities is very substantial, either through direct construction expenditures or the granting of huge amounts to aid the states and localities for highways and airports. What significance does this kind of government expenditure have for transportation generally?

Most obviously, the users of publicly provided transportation facilities such as highways, airports, or waterways are in competition with forms of transportation, such as railroads or pipelines, which do not receive the use of such publicly provided facilities. The railroad, for example, runs on its own track for which it pays its own cost of improvement, maintenance, interest, and taxes. If the user of the public facility does not pay an equitable share of the cost to the government, he in effect receives a subsidy to compete with a privately financed investment. Moreover, if public facilities are overdeveloped we may find government engaged in a long-run policy of encouraging the growth of some forms of transportation at the expense of others.

If government is to be fair or at least neutral in the competitive struggle among carriers of different modes, some using public facilities and some not, it must do two things: it must assess user charges for the cost of the facilities it provides and it must program its long-range investment in these facilities so as to recognize the contributions to over-all transport which private investment can make possible.

Both of these steps are difficult undertakings in view of the variety of ownership of the public facilities. The only leverage we have is the participation of federal funds in this kind of activity.

If user charges are assessed for the use of publicly provided transportation facilities, the rates charged for transportation will reflect the true cost of doing business including the cost of the public facilities. There is an uneven application of user charges among the several public investment programs. State highway programs are financed by special highway user taxes on motor vehicles, and, to the extent that these are equitable, competition of highway vehicles with other forms of transportation is equalized. The federal aid highway program is financed by federal user taxes. In the provision of inland waterways and ports and harbors, no user payments are required by the federal government. The result is that an asset of great commercial value is given away to commercial interests in competition with private investment. Government provided airway facilities in like manner are valuable facilities for which no charge is made by the federal government.

Our transportation report recommends the extension of user charges on a consistent basis to all publicly provided facilities.

A second problem of public investment is programming. How do we know that the expenditure of funds on a project is actually needed? Could not the same funds be used more profitably on some other kind of activity? This vexing problem has faced public management for centuries and has been solved in varying manner. For many years the ugly word "pork barrel" clung to public works activity. More recently there have been vast improvements in the methods of project evaluation, so that comparatively little money today is spent on capriciously selected projects. We are ready to move one step forward in the programming of public moneys for transportation facilities.

What we propose in our transportation report is that the programming of federal funds for publicly provided transport facilities be coordinated in one department, that this coordinated program be submitted to the President, and then submitted to the Congress as the Administration program through the federal budget.

This is being done today, but on a piecemeal basis with little coordination among programs, and with no recognition of the contributions made by private industry.

American Flag Operations in International Transportation

In international transportation we face our greatest difficulty in applying sound economic principles. We are faced with the competition of foreign flag airlines and merchant marines, and we have no sovereign control over their activities in international transportation. In the international sphere we are faced with our most pressing non-economic problems, and we expect our international carriers to assist with these international political objectives. We need a national merchant marine for strategic purposes. Air transportation is assuming a similar strategic role.

With so many factors outside the normal economic disciplines, we cannot escape a major element of governmental participation in international air and water transportation. We must subsidize where necessary to achieve our national diplomatic and strategic aims.

Past programs of international air and merchant marine promotion must be continued. We must stimulate research in cost saving methods and in new vehicles which increase the service potential of our national carriers.

General Governmental Policies

This brings us to the fourth concern of the transportation report; the impact of general policies of government on transportation. We take the position that transportation should be affected by other public policies to the same extent as industry generally. Transportation should receive no special favors from the influence of non-transportation policy; neither should it incur any special disabilities. Public policy of whatever nature should fall equally upon all industrial interests.

Many public policies of taxation, of government procurement, of labor management relations, or of national defense have had an impact on transportation more severe than in other industries. Moreover, these impacts have fallen more heavily on some forms of transportation than on others.

A good example of an unequal burden for transportation is in the provision of transportation to the government at free or reduced rates. Government has not always paid a fair price for its transportation. Often its special position under Section 22 of the Interstate Commerce Act enabled the government to obtain secret and unduly preferential rates. As a result of the Weeks Report, we obtained legislation requiring the publication of government rates generally. In the present transportation report we recommended further development of a rational rate policy by the government procurement agencies.

With respect to tax policy by the various levels of government, we find the main problem here is unequal burden falling on the competing forms of transportation. Distinguishing between taxation for general purposes and user charges for government facilities, the report concludes that certain federal taxes and tax regulations should be repealed or modified, that the social service burdens of the railroads be equalized with industry generally, and that more research effort be given to the impact of local taxation on the railroads.

In labor management relations the problem of work rules appears to be the outstanding one for transportation as an industry. We have recommended continuing cooperation of both labor and management in solving the work rule problem. We have also recommended the use of the good offices of the federal government to expedite solution in some instances.

In national defense we recognize that a healthy common carrier industry is the best guarantee of adequate defense transportation. We have recommended against the use of government owned transportation which would jeopardize in peacetime the common carrier services needed in time of emergency. This is a policy similar to the mobilization base concept used for industry generally, and we believe that adequate defense transportation can be obtained through general mobilization policies.

Program Objectives

As you have probably already concluded and as the Secretary said when he transmitted his report to the President, his primary responsibility was to and his primary interest was in the 180 million Americans who use the transportation facilities of the nation. Its objective is to keep available the facilities that are needed now and in the future.

It expresses the desire that this should be done in the traditional American way. During the past hundred years the modes of transportation, as we know them now, have come into being at different times, and each has been assisted and encouraged as it grew. At varying times, each has grown to maturity, and now, with minor exceptions, all are mature. Now, no one of them has a hold or monopoly on any part of the transportation business. In the American way, we desire that there should be freedom of competition so that each transportation service may be handled by him who can do it best.

The program plays no favorites. It is based on the premise that the public knows what it wants and is competent to judge the service it desires and the price it wants to pay. Whether the service is by rail, highway, water, air, or pipe; whether it is through the use of public or private facilities; whether it involves service by commercial carriers or private operators; or whether it is by any combination of any of these things, the public who use these facilities are competent to judge their needs. We would like the influence of the federal government to be as neutral between all carriers as we can make it and to allow the judgment between the services offered to be made in the market place.

We do not wish to be wasteful. We have tremendous resources in transportation on hand.

(Continued on page 19)

Is Criticism of the Federal Aid Highway Program Justified?

By Burton F. Miller

Deputy Executive Vice President
American Road Builders Association
Washington, D. C.

IN THE past several months there has been much ill-founded criticism leveled at the highway program and at officials and others responsible for carrying it forward.

Half truths have been used in such a way as to create erroneous impressions. In referring to the program, such expressions as "thrown together," "imperfectly conceived," "grossly mismanaged," have been used along with suggestions of extravagance, waste, and corruption.

Some even seriously question the propriety of federal aid for highways, charging that the federal government has no responsibility in this area and that the problem should be turned back to the states where, they say, it properly belongs. Indeed the present rash of charges and counter-charges has caused many in the ranks of Congress to wonder if the principle of federal aid for highways is basically sound.

Origin of Federal Aid

In such a disturbing atmosphere it might be well to look behind the scenes and refresh our memories regarding the origin of federal aid for good roads.

"Federal aid to good roads will accomplish several of the objects indicated by the framers of the Constitution—establish post roads, regulate commerce, provide for the common defense, and promote the general welfare."

This highly significant statement was the result of three years of intensive study by a joint Congressional committee which so reported to Congress in 1915. The report referred to is identified as House Document 1510, 63rd Congress, Third Session. It was this report that laid the groundwork for inauguration of the federal aid highway program in 1916.

Those who now criticize the interstate program as being poorly conceived and hastily thrown to-

gether should take a look at the record. Actually the interstate system was first proposed in 1922 and has been under constant study ever since.

Development of Interstate Program

During World War I there was a serious breakdown in transportation. Immediately after the war studies were undertaken toward development of a strategic network of highways. Thomas H. MacDonald, then Chief of the Bureau of Public Roads, initiated liaison with the War Department, in order to take cognizance of the needs of national defense in advancing the federal aid highway program.

As a result of this close cooperation with the War Department the so-called Pershing Map was developed and submitted to the Bureau of Public Roads in 1922. This map showed the highways in the United States considered most important from a military standpoint; suggested routes became part of the federal aid system.

Let us go back to the first report and follow through significant subsequent events that led up to our present interstate program.

First, let me refer to the report "Toll Roads and Free Roads," made by the Bureau of Public Roads pursuant to direction from Congress in 1938. The report stated that while entirely feasible from an engineering standpoint, a system of transcontinental superhighways could not be built with the expectation that the cost of constructing and operating such a system would be recoverable in any large part from direct tolls on the users.

Not content with making just a negative finding, the report recommended:

1. Construction of a special, tentatively defined system of direct interregional highways, with all necessary connections through and around cities, designed to meet the requirements of

¹ Reprinted from *American Road Builder*, May 1960

national defense in time of war and the needs of a growing peacetime traffic of longer range

2. Modernization of federal aid highway system
3. Elimination of railroad grade crossing hazards
4. Improvement of secondary and feeder roads, properly integrated with land-use programs
5. Creation of a Federal Land Authority empowered to acquire, hold, sell, and lease lands needed for public purposes and to acquire and sell excess lands for recouplement purposes

It is significant to note that all recommendations made in this 1939 report, except the one having to do with a Federal Land Authority, have since been covered by federal legislation.

As a follow-up to this report, President Roosevelt in 1940 requested the Public Roads Administration, as the Bureau was known at that time, to make a further survey "of our highway facilities from the viewpoint of national defense and advise me as to any steps that appear necessary."

The requested report was made to the President early in 1941 and printed as a Senate document of the 77th Congress for use of the Committee on Post Offices and Post Roads, which handled highway legislation in the Senate at that time.

To carry the record a step further, it should be noted that as a result of the recommendations in the first report, President Roosevelt, in 1941, appointed a National Interregional Highway Committee to investigate the need for a limited system of national highways.

While this Committee was engaged in its study, Congress, in 1943, directed the Commissioner of Public Roads "to make a survey of the need for a system of express highways throughout the United States; number of such highways needed; approximate routes which they should follow; approximate cost of construction; and to report to the President and to Congress within six months after the date of the Act results of the survey together with such recommendations for legislation as deemed advisable."

One report, entitled "Interregional Highways," sufficed for the two directives and was submitted to Congress on January 1, 1944. In the studies made by the Interregional Committee, highway systems of 29,300; 33,920; 36,000; and 48,400 miles were studied.

Urban Roads Controversy

Much has been said recently about urban portions of the interstate program, and some prominent persons have suggested that urban improvements were not a part of the original concept. To correct this impression, let me quote from the report on "Interregional Highways":

"All facts available to the Committee point to the sections of the recommended system within and in the environs of the larger cities and metropolitan areas as at once the most important in traffic service and least adequate in their present state of improvement. These sections include routes around as well as into and through the urban areas. If priority of improvement within the system be determined by either the magnitude of benefits resulting or the urgency of need, it is to these sections that first attention should be accorded."

It is generally recognized that the recommendations in this report had very strong bearing on the several new provisions of the Federal Aid Highway Act of 1944. This Act was a real milestone in federal highway legislation. For the first time, provision was made for a balanced federal aid highway program.

The Act not only provided for designation of the "interstate system," which term was substituted for "interregional," but also it authorized the designation of a system of secondary roads, appropriations for the primary system and new secondary system, and for the extension of these two systems into and through urban areas. For the first time, federal aid highway funds were earmarked specifically to urban areas.

National Defense Needs

To follow the sequence of events a step further, mention should be made of still another report entitled, "Highway Needs of the National Defense," which was made by the Bureau of Public Roads in 1949 pursuant to a Congressional directive.

This report reemphasized the importance of the interstate system to national defense and repeated some of the recommendations of previous reports. The need for a network of main arteries built to high standards and serving the entire country had been accumulating for many years. Traffic demands of World War II served to emphasize these

needs and also brought out clearly the vital role of such highways in national defense.

By 1947 the state highway departments and the Bureau of Public Roads in consultation with the military had selected intercity routes which were to make up the interstate system as originally authorized, and selection of additional urban radial and circumferential routes was completed in 1955. Thus the "interstate system," as it now is known, was in the process of development over a period of 38 years. This, indeed, is a far cry from the charge of being hastily thrown together.

Special funds for construction of the interstate system were first provided in 1952, but only in the token amount of \$25 million for each of the fiscal years 1954 and 1955.

In the meantime, the Subcommittee on Roads of the House of Representatives, under Chairmanship of the late Congressman MacGregor of Ohio, held extensive hearings, not on specific legislation but to provide Congress with current and comprehensive information as to highway needs. Then, in Section 13 of the Federal Aid Highway Act of 1954, Congress called for a "comprehensive study of all phases of highway financing, including a study of the cost of completing the several systems of highways in the several states."

Program Greatly Expanded

In 1954 the long years of planning culminated in greater support being generated for needed expansion in the highway program. In addition to the call by Congress for a new inventory of the nation's highway needs, President Eisenhower sent an urgent message to the Governors' Conference in June of that year in which he stressed the need for a greatly enlarged and accelerated highway program.

As a follow-up to his message to the Governors, the President appointed an advisory committee on a national highway program. This committee was headed by General Lucius D. Clay and now it is referred to as the Clay Committee. Its report, which was submitted to Congress in February of 1955, was based on extensive hearings and contained a series of conclusions and recommendations. The first conclusion was stated in these words:

"A safe and efficient highway network is essential to America's civil and national defense and to the economy. The existing system is inadequate

for both current and future needs. It must be improved to meet urgent requirements of a growing population and an expanding economy."

The Clay Committee recommended a 10 year program. Its report formed the basis for extensive hearings in Congress in 1955, but no legislation was enacted that year. The next year, 1956, Congress again tackled the problem and enacted the most important of all of our highway legislative milestones—The Federal Aid Highway Act of 1956. Many associations, including the American Association of State Highway Officials and the American Road Builders Association, made significant contributions in support of the legislation during the extensive hearings.

Part of ARBA's contribution consisted of Task Force reports which contained capability studies on planning and design, materials and supplies, construction, and machinery equipment. These studies were made with cooperation of the Bureau of Public Roads, state highway departments, and local highway officials.

The ARBA Task Force reports supported testimony of highway officials as to capability and did much to remove all doubt as to ability of the highway departments and the construction industry, including contractors, manufacturers of equipment, and materials suppliers, to effectively handle a greatly enlarged highway program.

It may appear that I am unduly laboring these issues. Perhaps so, but unfounded statements too frequently have a way of being accepted in important quarters. Many of the difficulties encountered in dealing with legislative matters may be charged to misinformation or a lack of reliable information.

Effect of Administrative Changes

To place this problem in its proper perspective, it is necessary to look again behind the scenes.

Not many years ago the federal aid highway program, legislatively speaking, was the sole responsibility of two committees of Congress—the Senate Committee on Post Offices and Post Roads and the House Committee on Roads. Because of an early provision of law providing for legal commitment of funds prior to actual appropriation, the Roads Committees not only established the scope of the federal aid highway program but at the same time determined the amount of federal funds to be appropriated.

There was no division of interest or responsibility. This system was followed for many years during which period the Roads Committees of the Congress became quite knowledgeable regarding highway matters.

However, with advent of the Legislative Reorganization Act of 1946, the situation was vastly changed. At this time the well established Roads Committees were abolished and highway matters were placed under the overall jurisdiction of a Public Works Committee in both the Senate and House of Representatives.

The newly organized Public Works Committees were burdened with many responsibilities in addition to highways. By necessity their interests were divided between highways and other public works, such as flood control, rivers and harbors, and public buildings.

Under such a setup the previous singularity of purpose no longer exists. Consequently, it is not reasonable to expect all members of the Public Works Committees to show the same interest or devote the time and study formerly evidenced by the previous standing committees on roads. While there are many highway-minded members of Congress serving on the Roads Subcommittees, we must not lose sight of the fact that there are others in key positions who are not quite so familiar with highway problems.

With enactment of the Federal Aid Highway Act of 1956 the situation became further involved. In this Act provision was made in Title II for the raising of revenue, which involved jurisdiction of two additional Committees of Congress (the House Ways and Means Committee and the Senate Finance Committee).

These two outstanding Committees include many of the most knowledgeable men in Congress. At the same time, it must be recognized that the Ways and Means Committee and the Finance Committee shoulder legislative burdens of tremendous proportions. These two Committees have the responsibility of raising revenue to finance the vast operations of the United States Government.

In view of such burdensome responsibilities, it may be concluded that these distinguished Committees have only limited time to go into the many facets of the federal aid highway program. Further complicating the problem, the Appropria-

tions Committees of both the House and Senate are now required to pass judgment as to the amount of federal funds to be provided for highways.

Current Studies and Investigations

In addition to the several standing Committees of Congress just referred to, the highway program is currently under study, or investigation, by two special Committees of the Congress; one is the Blatnik Committee, which is investigating all phases of the federal aid highway program; and the other, known as the Mills Committee, has under study the specific problem of highway finance.

Again, in the area of studies and investigations, other agencies are probing into the federal aid highway program. I refer to continuing investigations of the Bureau of the Budget, General Accounting Office, and work of the special study group appointed by President Eisenhower, which is generally known as the Bragdon Committee.

Reevaluation of Public Opinion Needed

It is not my purpose to discuss the merits of these various inquiries. Suffice it to say that they bring into sharp focus the need of constant effort to throw light on basic information regarding the federal aid highway program and its benefits to the public.

As to public benefits, it might be well to re-examine the 1915 report of the Joint Committee on Federal Aid Highways (which was previously cited). One question to be determined at the time was that of public opinion. In an effort to ascertain as accurately as possible public attitude, the Joint Committee undertook an extensive inquiry and found overwhelming support in favor of federal aid to good roads.

To paraphrase the findings of the 1915 report, replies representing 100,000 individuals were received from every state in the Union. It is most impressive to note that of the 100,000 persons represented in this survey, 97 per cent favored federal aid and only 3 per cent were against it.

The time has come for a reevaluation of public opinion regarding today's issues confronting orderly progress of the federal aid highway program. /NCSA

Expanded Highway Research Program Proposed

AN expanded national program of highway research, extending over the next 4 or 5 years at an estimated cost of \$34 million, was recently recommended in a special report to the Highway Research Board, a unit of the National Academy of Sciences National Research Council.

The report said that "a wider and deeper knowledge in every field of highway transportation is indispensable," and defined 19 broad areas of research, each of which "is adjudged to rate A-1 in importance and urgency."

Recommended research costs range from \$50,000 for studies of "Standards for Secondary and Rural Roads" up to \$10 million for "Improvement of Knowledge of Aggregates and Soils," which the report said is "most urgent because of the accelerating demand for roadbuilding materials and the diminishing supply of aggregates."

Suggested Research

The report, based on a 2 year study by a 5 man technical committee, suggested in connection with the research on soils that "possibly nuclear energy may transform clays and other now undesirable materials into useful aggregates."

Among other high priority investigations urged by the committee were projects in traffic safety, road maintenance, and the use of electronic devices in simulating traffic flow, controlling vehicles on the road, and simulating driver reactions behind the wheel.

Special Committee to Implement Program

The Special Committee was created by the Executive Committee of the Highway Research Board in June 1958, "to screen all available

Areas of Needed Research	Estimated Cost Over 4 or 5 Years	Suggested Source of Funds*
Controlling development of land in vicinity of freeway interchanges ..	\$ 200,000	P, F
Design, traffic control, and spacing of ramps and interchanges	500,000	P, O
Intensive investigation of accidents	2,000,000	P, F, I
Comprehensive study of passenger transportation in metropolitan areas ..	1,000,000	P, F
Comprehensive study of freight transportation by motor vehicle in rural and urban areas	500,000	P, F
Translation of the results of the AASHO road test in Illinois to conditions in other states	5,000,000**	O, P
Snow and ice removal or treatment	1,000,000	P, O
Improvement of highway maintenance	750,000	O
Improvement of knowledge of aggregates and soils	10,000,000	P, O, I
Improvement of techniques for forecasting traffic and revenues	250,000	P, F, O
Sharpening of figures of tangible road user benefits and development of method for appraising benefits now called intangible	500,000	P, O
Conceptual study of non-user and community benefits of highway construction in relation to user benefits	1,000,000	P or F, O
Warrants for lighting freeways	1,000,000	O, P, I
Standards for secondary and local roads	50,000	P, O
Development of driving simulator	3,500,000	P, F
Electronic control of vehicles	3,000,000	P, I
Analysis of the interactions of road and vehicle	500,000	P, I
Simulation of traffic flow	3,000,000	P, O
Improvement of motor vehicle administration	250,000	P, F

* P = Public; O = Operating; F = Foundation; I = Industry

** Research phases only

research data, set priorities, and estimate costs to get a program of highway research into motion as quickly as possible."

Chairman of the group is E. H. Holmes, Assistant Commissioner for Research of the U. S. Bureau of Public Roads. Other members are Harmer E. Davis, Director, Institute of Transportation and Traffic Engineering, University of California; W. A. Bugge, Director of Highways, State of Washington; F. V. Reagel, Engineer of Materials and Tests, Missouri Highway Department; and Otto H. Fritzsche, State Highway Engineer of New Jersey. Mr. Fritzsche was appointed last February to replace Charles M. Noble, formerly Director of Highways in Ohio.

The committee's report said that expanded research in this field has become critically urgent because highway transportation in the United States "has become more than a factor in the economy; it has become a part of the American way of life. The economic structure is utterly dependent on it."

Current expenditures for highway research are estimated at \$17.8 million annually by all agencies (excluding related industrial research privately financed), which the committee points out is equivalent to less than 1/5 of a cent out of every public dollar spent for highway construction, maintenance, and administration.

The recommended program would increase annual expenditures by about 38 per cent.

Areas of Needed Research

The 19 research areas given high priority by the committee were screened from 101 specific proposals which had been obtained from committees of the Highway Research Board, member departments of the American Association of State Highway Officials, and other interested agencies and institutions.

The 19 broader areas "of greatest urgency and importance," together with the committee's estimate of cost for needed research in each area, and its suggestions regarding appropriate sources of funds, are described. In each case the source of funds is one or more of the following 4 categories: "public," usually either federal or pooled state funds; "operating," funds regularly available to highway departments; "foundation"; and "industry." /NCSA

Transportation Policy

(Continued from page 13)

We have the skills and welfare of thousands who labor in the industry in which the investment of lifetimes has been made. We wish to discard no resources, to waste no skills, or put no one out of business. We propose to establish a trend and to gradually work toward the end we wish to accomplish.

The American public is the travelingest and shippingest people in the world and can pay for what it wants. Except in unusual situations, involving other than economic conditions, there is no reason why any transportation should be subsidized. There is no reason why the American public cannot have anything in the transportation field that it wants and is willing to pay for.

The objective of the Transportation Policy and Program recommended to the President is to achieve a healthy, versatile, unrestricted, progressive transportation facility, operated by American citizens as a part of the free enterprise of the nation and having the same opportunities to grow and prosper that are now enjoyed by other industries. /NCSA

Cover Photographs for the Crushed Stone Journal

The Editor of the **Crushed Stone Journal** would be pleased to consider all photographs that meet the following requirements:

1. Photographs must be of an NCSA member's quarry
2. Photographs should feature the quarry face; or, if an aerial view, must be readily identifiable as a crushed stone quarry
3. Photographs must be clear and sharp with good light and dark contrast and of good composition
4. Photographs should be vertical shots or suitable for cropping

All photographs should be sent to the National Crushed Stone Association, 1415 Elliot Place, N.W., Washington 7, D.C. If your photographs are not used they will be returned promptly.

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Church, H. F., Inc.

11 Carman Road, R.F.D. 3, Manchester, Conn.
Contract Drilling; Quarry Blast Holes

Clark Equipment Co.
Construction Machinery Division

P. O. Box 599, Benton Harbor, Mich.
Tractor Dozers, Tractor Scrapers, Tractor
Shovels, Tractor Wagons; Truck and Crawler
Excavator-Cranes

Continental Gin Co.
Industrial Division

P. O. Box 2614, Birmingham 2, Ala.
Conveyors—Belt, Screw, Flight, and Under-
ground Mine; Elevators—Bucket and Screw;
Feeders—Apron, Belt, Reciprocating, Table,
and Screw; Drives—V-Belts, Chains and
Sprockets, Gears and Speed Reducers

Contractors and Engineers Magazine

470 Park Ave., South, New York 16, N. Y.
Magazine of Modern Construction

Cross Perforated Metals Plant
National-Standard Co.

P. O. Box 507, Carbondale, Pa.
Cross Perforated Steel Segments, Sections,
Decks, for Vibrating, Shaking, Revolving,
and Other Types of Screening Equipment

Cummins Engine Co., Inc.

1000 Fifth St., Columbus, Ind.
Lightweight Highspeed Diesel Engines (60-600
Hp) for: On-Highway Trucks, Off-Highway
Trucks, Tractors, Earthmovers, Shovels,
Cranes, Industrial and Switcher Locomo-
tives, Air Compressors, Centrifugal Pumps,
Generator Sets and Power Units, Work
Boats, Motor Graders

Deister Machine Co.

1933 East Wayne St., Fort Wayne 4, Ind.
Deister Vibrating Screens, Classifiers, Washing
Equipment

Detroit Diesel Engine Division
General Motors Corp.

13400 West Outer Drive, Detroit 28, Mich.
GM Diesel—All Purpose Power Line of Light
Weight, 2 Cycle in Line and "V" Type
Diesels (20 to 1650 Hp in Only 3 Cylinder
Sizes) for On- and Off-Highway Trucks;
Tractors; Earthmoving and Construction
Equipment; Electric Generator Sets; Indus-
trial Power Units

Manufacturers Division – National Crushed Stone Association
(continued)

Diamond Iron Works

Division Goodman Manufacturing Co.

Halsted St. and 48th Place, Chicago 9, Ill.
Jaw and Roll Crushers; Vibrator, Revolving, and Scrubber Screens; Drag Washers; Bucket Elevators; Belt Conveyors; Bins; Apron and Plate Feeders; Portable Gravel and Rock Crushing, Screening, and Washing Plants; Stationary Crushing, Screening, and Washing Plants; Hammermills

Eagle Iron Works

P. O. Box 934, Des Moines 4, Iowa

Fine Material Screw Washers—Classifiers—Dehydrators; Coarse Material Screw and Log Washers—Dewaterers; Water Scalping and Fine Material Classifying Tanks; Stabilized Base Material Mixers; Drop Balls—Ni-Hard and Semi-Steel; "Swintek" Screen Chain Cutter Dredging Ladders; Revolving Cutter Head Dredging Ladders

Differential Co.

P. O. Box 238, Findlay, Ohio
Side Dump "Wagon Trains", Mine Cars, Locomotives, Car Dumpers

Easton Car & Construction Co.

Easton, Pa.

Off-Highway Transportation: Quarry Hauling Systems—Heavy-Duty Dump Trailers, Truck Bodies, and Cars for Mines, Quarries, and Earth Moving

Dixon Supply Co.

3104 Fourth Ave., South, Birmingham 5, Ala.
Conveyors—Belt

Electric Steel Foundry Co.

2141 N. W. 25th Ave., Portland 10, Oreg.
Esco Dragline Buckets, Shovel Dippers, Bucket Teeth, Crusher Wearing Parts, Cutting Edges and End Bits

Drill Carrier Corp.

P. O. Box 628, Salem, Va.
"Air-Trac" Drill Carrier

Ensign-Bickford Co.

660 Hopmeadow St., P. O. Box 308, Simsbury, Conn.
Primacord-Bickford Detonating Fuse and Safety Fuse

Du Pont of Canada Ltd.

85 Eglinton Ave., East, Toronto 12, Ontario, Canada
Explosives and Blasting Supplies

Euclid Division

General Motors Corp.

1361 Chardon Road, Cleveland 17, Ohio
Heavy-Duty Trucks and Dump Trailers for "Off-Highway" Hauls, Loaders for Earth Excavation, Single and Twin Engine Earth Moving Scrapers, Crawler Tractors

Du Pont, E. I. de Nemours & Co.

Wilmington 98, Del.
Explosives and Blasting Supplies

Dustex Corp.

25 Anderson Road, Buffalo 25, N. Y.
Dust Collecting Equipment; Dust Control Systems; Feeders

**Frog, Switch & Mfg. Co.
Manganese Steel Dept.**

Carlisle, Pa.
"Indian Brand" Manganese Steel Castings for All Types of Jaw, Gyratory, and Pulverizing Crushers; Dippers, Teeth, Treads, and Other Parts for Power Excavating Equipment; Other Miscellaneous Manganese Steel Castings; Railroad and Mine Frogs, Switches, Crossings

Eagle Crusher Co., Inc.

900 Harding Way East, Galion, Ohio
Crushers; Pulverizers; Hammermills; 4-Cage Disintegrating Mills; Portable Crushing Plants

Manufacturers Division – National Crushed Stone Association

(continued)

Gardner-Denver Co.

South Front St., Quincy, Ill.

Portable and Stationary Compressors, Rock Drills, "Air-Tracs," Self-Propelled Drills, Portable Rotary Drills, Sectional Drill Rods and Accessories, Air Hoists, Slusher Hoists, "Mole-Drills," Paving Breakers, Drill Steel, Gads, etc.

General Electric Co.

Locomotive & Car Equipment Dept.

2901 East Lake Road, Erie 1, Pa.

Electrical Apparatus, Locomotives

Geophysical Specialties Co.

15409 Robinwood Drive, Hopkins, Minn.

Miniature Engineering Seismograph—Model, MD-1—for Use in Locating and Mapping Sub-Surface Rock Topography

Gill Rock Drill Co., Inc.

Lebanon, Pa.

Well Drill Tools and Supplies

Gilson Screen Co.

110 Center St., Malinta, Ohio

Gilson Testing Screen, Gilson "Porta-Screen," Accessories for Test Sizing of Concrete Aggregates

Goodrich, B. F., Industrial Products Co.

500 South Main St., Akron 18, Ohio

Industrial Rubber Products—Belting (Conveyor, Elevator, Transmission), V-Belts, Hose (Air, Water, Steam, Suction, Misc.); Rubber Chute Lining; Storage Batteries (Automobile, Truck, Tractor); Tires (Automobile, Truck, Off-the-Road); Tubes (Automobile, Truck, Off-the-Road); Industrial Tires and Tubes

Goodyear Tire & Rubber Co.

Akron 16, Ohio

Airfoam; Industrial Rubber Products—Belting (Conveyor, Elevator, Transmission); Hose (Air, Water, Steam, Suction, Miscellaneous); Chute Lining (Rubber); Rims (Truck, Tractor); Storage Batteries (Automobile, Truck, Tractor); Tires (Automobile, Truck, Off-the-Road); Tubes (Automobile, Truck, Off-the-Road)

Gulf Oil Corp.

P. O. Box 1166, Pittsburgh 30, Pa.

Lubricating Oils, Greases, Gasoline and Diesel Fuels

Hardinge Co., Inc.

240 Arch St., York, Pa.

Process Equipment for Grinding, Pulverizing, Drying, Thickening, Classifying, Feeding, Calcining, Cooling, Washing

Harnischfeger Corp.

4400 West National Ave., Milwaukee 46, Wis.

Complete Line of Power Cranes, Shovels, Draglines, Overhead Cranes, Hoists, Welders, Electrodes, Generators, Diesel Engines

HarriSteel Products Co.

420 Lexington Ave., New York 17, N. Y.

Woven Wire Screen Cloth

Heidenreich, E. Lee, Jr.

Consulting Engineers

75 Second St., Newburgh, N. Y.

Plant Layout, Design, Supervision; Open Pit Quarry Surveys; Appraisals—Plant and Property

Hendrick Mfg. Co.

Carbondale, Pa.

Perforated Metal Screens, Perforated Plates for Vibrating, Shaking, and Revolving Screens; Elevator Buckets; Test Screens; Wedge Slot Screens; Wedge Wire Screens; Open Steel Floor Grating

Hercules Powder Co.

Wilmington 99, Del.

Explosives and Blasting Supplies

Hetherington & Berner, Inc.

701-745 Kentucky Ave., Indianapolis 7, Ind.

Asphalt Paving Machinery, Sand and Stone Dryers

Manufacturers Division – National Crushed Stone Association

(continued)

Hewitt-Robins Incorporated

666 Glenbrook Road, Stamford, Conn.

Belt Conveyors (Belting and Machinery); Belt and Bucket Elevators; Car Shakeouts; Feeders; Industrial Hose; Screen Cloth; Sectional Conveyors; Skip Hoists; Stackers; Transmission Belting; Vibrating Conveyors, Feeders, and Screens; Design and Construction of Complete Plants; Molded Rubber Goods; Sheet Packing; Transmission Belting; De-waterizers; Wire Conveyor Belts; Speed Reducers; Gears; Pulleys; Sheaves; Couplings

Hoyt Wire Cloth Co.

P. O. Box 1577, Lancaster, Pa.

Aggregate Wire Screens Made of Supertough, Abraso, and Stainless Steel Wire—Smooth-top, Longslot, Oblong Space, and Double Crimp Construction—For All Makes of Vibrators; Rubber Bucker Up Channel

Hughes Tool Co.

P. O. Box 2539, Houston 1, Texas

Bits—Rotary Rock

Ingersoll-Rand Co.

11 Broadway, New York 4, N. Y.

Rock Drills, Paving Breakers, Paving Breaker Accessories, Quarrymaster Drills, Drillmasters, Waterwell Drills, Down-Hole Drills, Crawl-ir Drills and Wagon Drills, Carset Bits, Jackbits, Bit Reconditioning Equipment, Portable and Stationary Air Compressors, Air Hoists, Slusher Hoists, Pneumatic Tools, Centrifugal Pumps, Diesel and Gas Engines, Blowers and Fans

International Harvester Co.

Construction Equipment Division

P. O. Box 270, Melrose Park, Ill.

Crawler Tractors and Equipment, Rubber Tired Scrapers and Bottom Dump Wagons, Off-Highway Dump Trucks, Carbureted and Diesel Power Units

Iowa Manufacturing Co.

916 16th St., N. E., Cedar Rapids, Iowa

Rock and Gravel Crushing, Screening, Conveying and Washing Plants, Asphalt Plants, Stabilizer Plants, Impact Breakers, Screens, Elevators, Conveyors, Portable and Stationary Equipment, Hammermills, Bins

Jaeger Machine Co.

550 West Spring St., Columbus 16, Ohio

Portable and Stationary Air Compressors, Self-Priming Pumps, Truck Mixers, Concrete Mixers, Road Paving Machinery, Hoists and Towers; Finishers—Concrete; Spreaders—Stone and Concrete; Truck Mixers—Concrete

Jeffrey Manufacturing Co.

815 North Fourth St., Columbus 16, Ohio

Elevator Buckets; Car Pullers; Chains; Conveyors; Belt, Drag, Apron, Vibrating; Idlers; Crushers; Pulverizers; Elevators; Feeders; Pillow Blocks; Grizzlies; Screens

Joy Manufacturing Co.

333 Henry W. Oliver Bldg., Pittsburgh 22, Pa.

Drills: Blast-Hole, Wagon, Rock, and Core; Air Compressors: Portable, Stationary, Semi-Portable; Aftercoolers; Portable Blowers; Carpullers; Hoists: Multi-Purpose, Portable; Rock Loaders; Air Motors; Trench Diggers; Belt Conveyors; "Spaders;" "String-a-Lite" (Safety Lighting Cable); Backfill Tampers; Drill Bits: Rock Core; Joy Microdyne Dust Collectors

Kennedy Van Saun Mfg. & Eng. Corp.

405 Park Ave., New York 22, N. Y.

Crushing, Screening, Washing, Conveying, Elevating, Grinding, Complete Cement Plants, Complete Lime Plants, Complete Lightweight Aggregate Plants, Synchronous Motors, Air Activated Containers for Transportation of Pulverized Material, Cement Pumps, and Power Plant Equipment

Kensington Steel

Division of Poor & Co., Inc.

505 East Kensington Ave., Chicago 28, Ill.

Oro Alloy and Manganese Steel Castings; For Shovels—Dipper Teeth, Crawler Treads, Rollers, Sprockets; For Crushers—Jaw Plates, Concaves, Concave Rings, Mantles; For Pulverizers—Hammers, Grate Bars, Liners; For Elevators and Conveyors—Chain, Sprockets, Buckets; For Tractors—Sprocket Rims, Grouser Plates; Drag Line Chain

Koehring Division

Koehring Co.

3026 West Concordia Ave., Milwaukee 16, Wis.

Excavating, Hauling, and Concrete Equipment

Manufacturers Division — National Crushed Stone Association

(continued)

LeTourneau-Westinghouse Co.

2301 North Adams St., Peoria, Ill.
Earthmoving Equipment, Motor Graders, Off-Highway Trucks, Wire Rope

Link-Belt Co.

300 West Pershing Road, Chicago 9, Ill.
Complete Stone Preparation Plants; Conveyors, Elevators, Screens, Washing Equipment, and Power Transmission Equipment

Link-Belt Speeder Corp.

1201 Sixth St., S. W., Cedar Rapids, Iowa
Complete Line of Speed-o-Matic Power Hydraulically Controlled Cranes, Shovels; Hoes, Draglines, and Clamshells, 1/2 to 3-Yd Capacities; Available on Crawler Base or Rubber Tire Mounting; Diesel Pile Hammers

Lippmann Engineering Works, Inc.

4603 West Mitchell St., Milwaukee 14, Wis.
Primary and Secondary Rock Crushers and Auxiliary Equipment such as Feeders, Screens, Conveyors, etc., Portable and Stationary Crushing and Washing Plants

Ludlow-Saylor Wire Cloth Co.

634 South Newstead Ave., St. Louis 10, Mo.
Woven Wire Screens of Ludloy (Oil Tempered); Super-Loy (Hi-Carbon); Steel; Stainless Steel; All Other Commercial Alloys

Mack Trucks, Inc.

1355 West Front St., Plainfield, N. J.
4- and 6-Wheeled Trucks and Tractors—Gasoline- and Diesel-Powered from 5 to 12 Cu Yd Capacity with a Wide Choice of Transmissions and Front and Rear Axles with 2-, 4-, and 6-Wheel Drives; 4- and 6-Wheeled Off-Highway Vehicles from 15- to 40-Ton Capacity with Diesel Power Plants Available from 170 to 400 Hp

Manganese Steel Forge Co.

Richmond St. and Castor Ave., Philadelphia 34, Pa.
Rol-Man 11.00 to 14.00 Per Cent Rolled Manganese Steel Woven and Perforated Screens, and Fabricated Parts for Aggregate Handling Equipment

Marion Power Shovel Co.

Division of Universal Marion Corp.

617 West Center St., Marion, Ohio
Power Shovels, Draglines, Cranes, Truck Cranes—From 3/4 to 75 Yd

Marsh, E. F., Engineering Co.

4324 West Clayton Ave., St. Louis 10, Mo.
Belt Conveyors

Mayhew Supply Co., Inc.

4700 Scyene Road, Dallas 17, Texas
Blast Hole Drill Rigs

McLanahan & Stone Corp.

252 Wall St., Hollidaysburg, Pa.
Complete Pit, Mine, and Quarry Equipment—Crushers, Washers, Screens, Feeders, etc., Semi-Portable Plants

Meissner Engineers, Inc.

300 West Washington St., Chicago 6, Ill.
Engineers—Constructors—Specialists in Plant Layout, Construction-Engineering Design, Procurement, Construction Management, Quarry Surveys, Plant and Property Appraisals

Murphy Diesel Co.

5317 West Burnham St., Milwaukee 19, Wis.
Engines—Industrial Engine, and Power Units for Operation on Diesel and Dual Fuel Engines. Generator Sets, AC and DC from 64 to 165 kw. Mech-Elec Unit—Combination Mechanical and Electric Power Furnished Simultaneously

New Jersey Drilling Co., Inc.

Box 251, Route 206, Netcong, N. J.
Contract Drilling; Quarry Blast Holes

New York Rubber Corp.

100 Park Ave., New York 17, N. Y.
Conveyor Belting; Stonore, Dependable, and Cameo Grades; Transmission Belting: Silver Duck Duroflex, Soft Duck Rugged, Commercial Grade Tractor

Manufacturers Division — National Crushed Stone Association

(continued)

Nordberg Mfg. Co.

3073 South Chase Ave., Milwaukee 1, Wis.

Symons Cone Crushers, and Symons Gyratory and Impact Crushers; Gyradisc Crushers; Grinding Mills; Stone Plant and Cement Mill Machinery; Vibrating Screens and Grizzlies; Diesel Engines and Diesel Generator Units; Mine Hoists; Railway Track Maintenance Machinery

Northern Blower Co.

6409 Barborton Ave., Cleveland 2, Ohio

Dust Collecting Systems, Fans—Exhaust and Blower

Northwest Engineering Co.

135 South LaSalle St., Chicago 3, Ill.

Shovels, Cranes, Draglines, Pullshovels—Crawler and Truck Mounted

Olin Mathieson Chemical Corp. Energy Division

East Alton, Ill.

Explosives, Blasting Caps, Blasting Accessories

Pennsylvania Crusher Division Bath Iron Works Corp.

323 South Matlack St., West Chester, Pa.

Single Roll Crushers, Impactors, Reversible Hammermills, Ring Type Granulators, Kue-Ken Jaw Crushers, Kue-Ken Gyratories, Non-Clog and Standard One-Way Hammermills

Pettibone Mulliken Corp.

4710 West Division St., Chicago 51, Ill.

Tractor Shovels, Front End Loaders, Swing Loaders, Yard Cranes, Bucket and Fork Loaders, Motor Graders, Manganese Steel Castings, Material Handling Buckets, Clamshells, Draglines, Pull Shovel Dippers, Shovel Dippers, and Pumps

Pioneer Engineering Division of Poor & Co., Inc.

3200 Como Ave., Minneapolis 14, Minn.

Jaw Crushers, Roll Crushers (Twin and Triple), Impact Crushers, Hammer-Mills, Vibrating and Revolving Screens, Feeders (Reciprocating, Apron, and Pioneer Oro Manganese Steel), Belt Conveyors, Idlers, Accessories and Trucks, Portable and Stationary Crushing and Screening Plants, Washing Plants, Mining Equipment, Cement and Lime Equipment, Asphalt Plants, Mixers, Dryers, and Pavers

Pit and Quarry Publications, Inc.

431 South Dearborn St., Chicago 5, Ill.

Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Modern Concrete, Concrete Industries Yearbook, Equipment Distributor's Digest

Productive Equipment Corp.

2926 West Lake St., Chicago 12, Ill.

Vibrating Screens

REICHdrill Division Chicago Pneumatic Tool Co.

6 East 44th St., New York 17, N. Y.

Air Compressors, Rock Drills, Diesel Engines, Pneumatic Tools, Rotary and "Down-the-Hole" Drilling Machines for Exploration, Coring, Blast Holes

Rock Products

79 West Monroe St., Chicago 3, Ill.

Publications: Rock Products and Concrete Products

Rogers Iron Works Co.

11th and Pearl Sts., Joplin, Mo.

Jaw Crushers, Roll Crushers, Hammermills, Vibrating Screens, Revolving Screens and Scrubbers, Apron Feeders, Reciprocating Feeders, Roll Grizzlies, Conveyors, Elevators, Portable and Stationary Crushing and Screening Plants, Mine Hoists, Drill Jumbos, Underground Loaders, Iron Castings, Screw Washers, and Classifying Tanks

Schramm, Inc.

West Chester, Pa.

Air Compressors: Portable and Stationary, Gasoline, Diesel, and Electric Driven; Boosters; Pneumattractors, Self-Propelled; Accessories; Bits—Rock; Rotatool Bits, Carbide Insert; Drills, Drilling Equipment; Rotadrills Mounted on Pneumattractors, Trucks and Crawlers; Ready-to-Mount Rotadrills for Mounting on Used Trucks and Crawler Tractors; Rotatools for Bottom-Hole Drilling; Rock Drills; Wagon Drills; Breakers; Accessories

Screen Equipment Co., Inc.

40 Anderson Road, Buffalo 25, N. Y.

Seco Vibrating Screens; Scales—Industrial, Aggregates, Truck

Manufacturers Division – National Crushed Stone Association

(continued)

Simplicity Engineering Co.

Durand, Mich.

Simplicity Gyrating Screens, Horizontal Screens, Simpli-Flo Screens, Tray Type Screens, Heavy Duty Scalpers, D'Watering Wheels, D'Centegrators, Vibrating Feeders, Vibrating Pan Conveyors, Car Shake-Outs, Woven Wire Screen Cloth, Grizzly Feeders

Smith Engineering Works

532 East Capitol Drive, Milwaukee 12, Wis.

Gyratory, Gyrasphere, Jaw and Roll Crushers, Vibrating and Rotary Screens, Gravel Washing and Sand Settling Equipment, Elevators and Conveyors, Feeders, Bin Gates, and Portable Crushing and Screening Plants

Stardrill-Keystone

Buffalo Springfield Co.

Division of Koehring Co.

1100 Kenton St., Springfield, Ohio

Drilling Machines: Rotary Air Drills, Churn Drills, Rotary Tools, Rotary Bits, Down-the-Hole Guns, Insert Type Bits, and Water Well Drills

Stedman Foundry & Machine Co., Inc.

P. O. Box 209, Aurora, Ind.

Stedman Impact-Type Selective Reduction Crushers, 2-Stage Swing Hammer Limestone Pulverizers, Multi-Cage Limestone Pulverizers, Vibrating Screens

Stephens-Adamson Mfg. Co.

Ridgeway Ave., Aurora, Ill.

Belt Conveyors, Pan Conveyors, Bucket Elevators, "Amsco" Manganese Steel Pan Feeders, Vibrating Screens, Belt Conveyor Carriers, Bin Gates, Car Pullers, "Sealmaster" Ball Bearing Units, "Saco" Speed Reducers, and Complete Engineered Stone Handling Plants

Taylor-Wharton Co.

Division Harsco Corp.

High Bridge, N. J.

Manganese and Other Special Alloy Steel and Iron Castings; Dipper Teeth, Fronts and Lips; Crawler Treads; Jaw and Cheek Plates; Mantles and Concaves; Pulverizer Hammers and Liners; Asphalt Mixer Liners and Tips; Manganese Nickel Steel Welding Rod and Plate; Elevator, Conveyor, and Dredge Buckets; Pan Feeders

Thew Shovel Co.

East 28th St. and Fulton Road, Lorain, Ohio

"Lorain" Power Shovels, Cranes, Draglines, Clamshells, Hoes on Crawlers and Rubber Tire Mountings: Diesel, Electric, and Gasoline, 3/8 to 2 1/2 Yd Capacities; "Lorain" Motor-Loader—Rubber Tire Front End Loader 1 3/4 and 2 Yd Capacity

Thor Power Tool Co.

175 North State St., Aurora, Ill.

Crawler and Hand-Held Rock Drills, Sump and Sludge Pumps, Clay Diggers, Paving Breakers, Quarry Bars, Sinker Legs, Drifters, Rock Drilling Jumbos, Raiser Legs, Push Feed Rock Drills, Air and Electric Tools, Accessories, Generator Sets, Concrete Vibrators, Power Trowels, Vibratory Screeds

Timken Roller Bearing Co.

Service-Sales Division

1835 Dueber Ave., S. W., Canton 6, Ohio

"Timken"—Tapered Roller Bearings; Alloy Steel; Rock Bits

Torrington Co.

Bantam Bearings Division

3702 West Sample St., South Bend 21, Ind.

Anti-Friction Bearings; Self-Aligning Spherical, Tapered, Cylindrical, and Needle Roller; Roller Thrust; Ball Bearings

Traylor Eng. & Mfg.

Division of Fuller Co.

Allentown, Pa.

Stone Crushing, Gravel, Lime, and Cement Machinery

Trojan Powder Co.

17 North Seventh St., Allentown, Pa.

Explosives and Blasting Supplies

Tyler, W. S., Co.

3615 Superior Ave., N. E., Cleveland 14, Ohio

Woven Wire Screens; Ty-Rock, Tyler-Niagara and Ty-Rocket (Mechanically Vibrated) Screens; Hum-mer Electric Screens; Ro-Tap Testing Sieve Shakers, Tyler Standard Screen Scale Sieves, U. S. Sieve Series

Manufacturers Division – National Crushed Stone Association

(continued)

Universal Engineering Corp.

Subsidiary of Pettibone Mulliken Corp.

625 C Ave., N. W., Cedar Rapids, Iowa

Crushers—Jaw, Roll, TwinDual Roll; Hammermills, Impact Breakers, Pulverizers, Bins, Conveyors, Feeders, Screens, Scrubbers. Bulldog Non-Clog Moving Breaker Plate and Stationary Breaker Plate Hammermills, Center Feed Hammermills. Complete Line of Stationary and Portable Crushing, Screening, Washing, and Loading Equipment for Rock, Gravel, Sand, Ore; Aglime Plants; Asphalt Plants

Varel Manufacturing Co.

9230 Denton Drive, Dallas 20, Texas

Rock Bits, Drilling; Bits: Diamond, Blade, Drag

Vibration Engineering Co.

407 Hazleton National Bank Bldg.,
Hazleton, Pa.

Consultants on Vibration and Blast Effects; Seismograph Sales, Rental and Record Interpretation; Pre-Blast and Post-Blast Property Inspections; Seismic and Resistivity Rock Depth Surveys; Rock Velocity Measurements

Vibration Measurement Engineers, Inc.

725 Oakton St., Evanston, Ill.

Seismographic and Airblast Measurements, Seismological Engineering, Blasting Complaint Investigations, Expert Testimony in Blasting Litigation; Complete Seismograph Rental and Record Analysis Service with "Seismolog"

Webb, Jervis B., Co.

8951 Alpine Ave., Detroit 4, Mich.

Design and Construction of Complete Material Handling Systems; Conveyors—Belt and Flight; Bucket Elevators; Feeders; Forged Chain

Werco Steel Co.

2151 East 83rd St., Chicago 17, Ill.

Castings—Manganese, Alloy Steel; Screen Plates—Perforated Steel Screen Sections and Decks; Buckets; Chains; Belt Conveyors, Idlers; Dipper—Shovel; Drop Balls; Wire Cloth; Wire Rope and Related Products; Crushers, Pulverizers

Western-Knapp Engineering Co.

50 Church St., New York 7, N. Y.

Plant Design and Construction Operating Studies; Appraisals

White Motor Co.

842 East 79th St., Cleveland 1, Ohio

On- and Off-Highway Trucks and Tractors—Gasoline- and Diesel-Powered; Industrial Engines—Gasoline and Diesel; Power Units, Axles, Special Machine Assemblies; Power Generating and Distributing Systems; Batteries; All Classes of Maintenance and Repair Service

White Motor Co.

Autocar Division

Exton, Pa.

Custom Engineered, Precision Built Trucks and Tractors for On- or Off-Highway: Gasoline or Diesel Powered, 2 or 3 Axles, Single Axle to All Axle Drives; Planetary Gear Driven Vehicles for Quarry, Mine, and Construction Operations

Wickwire Spencer Steel Division

Colorado Fuel and Iron Corp.

575 Madison Ave., New York 22, N. Y.

Wire Cloth, Screens, Screen Sections, Wire Rope—Slings

Williams Patent Crusher & Pulverizer Co.

2701-2723 North Broadway, St. Louis 6, Mo.

Hammer Mills, Crushers, Pulverizers, Roller Mills, Reversible Impactors, Vibrating Screens, Air Separators, Bins, Feeders

Wiss & Associates

570 Northwest Highway, Des Plaines, Ill.

Seismological Engineers

44th Annual Convention

NATIONAL CRUSHED STONE ASSOCIATION

SCHEDULE OF EVENTS

Tuesday . . . January 17

- MORNING — GENERAL SESSION
- NOON — GREETING LUNCHEON
- AFTERNOON — OPEN FOR INDIVIDUAL PLANS
 - COCKTAIL HOUR
- EVENING — OPEN FOR INDIVIDUAL PLANS

Wednesday . . . January 18

- MORNING — CONCURRENT SESSIONS
 - SESSION FOR OPERATING MEN AND EQUIPMENT MANUFACTURERS
 - SESSION FOR SALESMEN
- NOON — GENERAL LUNCHEON
- AFTERNOON — SESSION FOR EXECUTIVES AND FINANCE OFFICERS
- EVENING — OPEN FOR INDIVIDUAL PLANS

Thursday . . . January 19

- MORNING — CONCURRENT SESSIONS
 - ROUND TABLE DISCUSSIONS FOR OPERATING MEN AND EQUIPMENT MANUFACTURERS
 - SESSION ON FEDERAL LABOR STANDARDS
- NOON — MANUFACTURERS DIVISION LUNCHEON
- AFTERNOON — OPEN FOR INDIVIDUAL PLANS
- EVENING — PATIO PARTY

Friday . . . January 20

- MORNING — GENERAL SESSION
- ADJOURNMENT

AMERICANA, BAL HARBOUR, MIAMI BEACH, FLORIDA

JANUARY 17 - 20, 1961



